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Demographic monitoring of *Arabis fecunda*



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DEMOGRAPHIC MONITORING OF ARABIS FECUNDA
IN THE SAPPHIRE RANGE, RAVALLI COUNTY, MONTANA

1990 PROGRESS REPORT

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INTRODUCTION

In order to adequately protect populations of an organism, it is necessary to understand its life history and population dynamics (Massey and Whitson 1980, Sutter 1986, Palmer 1987). Sapphire rockcress (Arabis fecunda Rollins) is a rosette-forming perennial in the Mustard Family (Brassicaceae). This recently described species (Rollins 1984) is endemic to highly calcareous, azonal soils in the foothills of the Sapphire Range in Ravalli County and in the Pioneer Range in Beaverhead and Silver Bow counties, Montana (Lesica 1985, Schassberger 1988). Arabis fecunda occurs on eroding slopes with low vascular plant density but often a relatively high cover of cryptogamic soil crust. In Ravalli County, populations of Arabis fecunda are thought to be threatened by livestock grazing and encroachment by an aggressive exotic weed, spotted knapweed (Centaurea maculosa) (Lesica 1985). Arabis fecunda is a candidate for listing as a threatened or endangered species by the U.S. Fish and Wildlife Service (USDI, FWS 1990) and is considered threatened in Montana (Lesica and Shelly 1991).

This paper is a progress report on a long-term demographic monitoring study of A. fecunda populations, established in order to determine important life history attributes and determine trends in overall recruitment and mortality.

METHODS

Study Areas

We conducted our studies at two sites in Ravalli County, Montana: Charley's Gulch and Birch Creek. The Charley's Gulch site is on a steep, eroding, southwest-facing slope along the gulch at an elevation of ca. 5,000 ft. (T6N R19W S29,NW1/4). The Birch Creek site is on a steep, eroding, southeast-facing slope above the creek at an elevation of ca. 4,700 ft. (T7N R19W S16,NW1/4). More complete descriptions of the study sites can be found in Lesica (1985) and Schassberger (1988).

In May, 1987, we established permanent belt transects of 12 adjacent 1-m² plots at both sites following the methods outlined in Lesica (1987). Individual A. fecunda plants were mapped and recorded using the following system:

- S = Seedling (rosette less than 15 mm diameter)
- R - indicates the number of rosettes (> 15 mm diameter) per plant
- I - indicates the total number of inflorescences (stems) per plant
- F - indicates the total number of fruits produced by the plant

Thus, a plant with two rosettes, three stems and a total of nine fruits would be recorded as R1-I3-F9. In cases where plants had not finished blooming, two flowers or flower buds were recorded as one fruit. Since a first year plant can bloom and set fruit (Lesica and Shelly, personal observation), the above system describes size rather than age classes.

We also noted the presence of recently disturbed soil and evidence of livestock trampling. We did not record seedling-size plants at the Birch Creek site in 1987. We collected 25 randomly selected fruits at each site starting in 1989. Each fruit was hand-dissected and the number of seeds in each was recorded. We read the transects on May 19-20, 1987; May 19-20, 1988; May 24-25, 1989 and May 29-30, 1990. In 1987 we recorded data from 12 quadrats at Birch Creek. In 1988 this number was increased to 14.

Population growth rate was calculated by dividing the increase in individuals over the previous year divided by the number of individuals present in the plot the previous year. Negative growth rates reflect a decreasing population size.

RESULTS AND DISCUSSION

A summary of the data from four years of long-term monitoring is presented in Table 1. Fecundity, as measured by percentage of plants fruiting, fruits/plant, fruits/inflorescence and seeds/fruit increased or was stable at Charley's Gulch in 1990 compared to 1989; however, these same parameters were all noticeably lower at Birch Creek. Population growth was positive at Charley's Gulch but negative at Birch Creek.

In 1989 most of Montana received above-normal precipitation in late summer and early autumn, and although snowpack was light in southwestern Montana during the following winter, late spring precipitation was also above average. Since germination of Arabis fecunda seed occurs readily without any cold treatment, the wet period in late summer and early autumn should have resulted in high levels of recruitment and strong seedling growth. Both higher than average levels of autumn and spring precipitation should have resulted in an increase in fecundity. Arabis fecunda populations at Charley's Gulch did experience an increase in both recruitment and fecundity. The negative response at Birch Creek, only five miles distant, is difficult to explain. Negative growth may be the result of mortality due to disturbance of the habitat by livestock or ungulate grazers, but we did not observe recent slumping of the soil as in 1988. Future observations may help explain this dilemma.

Table 1. Population density and fecundity data for Arabis
fecunda in long-term monitoring transects, 1987-
1990.

		<u>Birch Creek</u>	<u>Charley's Gulch</u>
Density (plants/m ²)	1987	4.8	6.5
	1988	4.6	6.0
	1989	4.9	5.5
	1990	4.6	7.0
Population growth	1988	-0.14	-0.08
	1989	0.05	-0.08
	1990	-0.07	0.18
% plants fruiting	1987	35%	42%
	1988	11%	15%
	1989	47%	36%
	1990	27%	42%
# fruits per fruiting plant	1987	3.8	5.1
	1988	14.0	8.8
	1989	22.0	15.8
	1990	4.4	16.0
# fruits per inflorescence	1987	2.2	2.1
	1988	5.2	3.0
	1989	6.8	3.9
	1990	2.4	3.7
% plants with more than one rosette	1987	9%	27%
	1988	8%	38%
	1989	9%	30%
	1990	8%	25%
% one-rosette plants with fruit	1987	29%	37%
	1988	12%	22%
	1989	45%	35%
	1990	25%	34%
% multi-rosette plants with fruit	1987	83%	57%
	1988	0%	4%
	1989	67%	40%
	1990	40%	62%
Mean # seeds per fruit (\pm SD, n=25)	1989	38.6 \pm 5.6	32.3 \pm 4.7
	1990	30.4 \pm 5.6	31.2 \pm 5.2

The percentage of plants with more than one rosette has remained constant at both sites for the entire period of our study. The Charley's Gulch population has consistently had 3-4 times as many multi-rosette plants as Birch Creek. We do not know if this difference is a result of a plastic response to environmental differences or genetic differences between the two populations.

To date we have observed the two populations for a period of three years. During this time fecundity and recruitment have fluctuated in both populations. Nonetheless, no definite trends are discernable, and both populations appear to be stable.

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Appendix A. Performance of individual Arabis fecunda plants in permanent monitoring transects in Ravalli County in 1987, 1988 and 1989. Seedlings were not recorded at Birch Creek in 1987. An asterisk (*) indicates a plant lost due to slumping soil. A "b" indicates a plant that has "bolted," produced an inflorescence from the terminal bud.

Charley's Gulch				
	<u>1987</u>	<u>1988</u>	<u>1989</u>	<u>1990</u>
1.	S	R1	R1-I3-F10	R1-I5-F19
	R1-I1-F2	R1-I1-F3	R3	R3-I3-F9
	S	R2	R2-I3-F9	R2-I4-F27b
	S	R1	--	--
	R1-I4-F15	R1-I5-F23	--	--
	--	--	S	--
	--	--	--	S
2.	S	R1-I1-F6	R1-I6-F31	--
	--	--	--	R1
3.	NO PLANTS			
4.	R1-I3-F5	R1	R1-I6-F33	R1-I1-F3
	R2-I4-F11	R2-I1-F5	R2-I13-F58	R2-I6-F19
5.	S	--	--	--
	R1-I5-F15	R1-I2-F5	R1	R1-I3-F14
	--	--	--	S
6.	S	--	--	--
b	R1-I1-F4	R1-I1-F5	--	--
c	R1-I5-F13	R1-I2-F12	R1	R1-I4-F15
d	--	R2	--	--
e	--	S	--	--
f	--	S	--	--
g	--	S	--	--
h	S	R1	R1	R1-I1-F4
i	--	--	S	--
j	--	--	S	R1
k	--	--	--	S
l	--	--	--	S
m	--	--	--	S
n	--	--	--	R1
o	--	--	--	S
p	--	--	--	S
q	--	--	--	S
r	--	--	--	S
s	--	--	--	R1
t	--	--	--	R1
u	--	--	--	S

7.	R1-I5-F11	R1-I13-F17	--	R1-I5-F17
b	R1-I1-F2	R2	R2-I4-F9	R2
c	R1-I2-F3	--*	--	--
d	S	S	--	--
e	S	R2	R3-I5-F21	R2-I5-F18
f	R1-I3-F1	R1-I4-F17	R1-I5-F17	R1-I7-F27
g	--	--	R1	R1
h	--	--	R1	R1
i	--	--	R1	R1
j	--	--	--	S
k	--	--	--	S
8.	S	R1	R1-I6-F29	R1
b	S	--	--	--
c	S	--	--	--
d	S	R1	R1-I6-F42	R1-I1-F8
e	S	R1	R1-I2-F12	R1-I4-F1
f	R2-I1-F1	R2	R2	R1
g	S	R1	--	--
h	R1-I3-F2	R1-I1-F2	R1	R1
i	R2	R2	--	--
j	R1-I4-F9	R2	R2-I7-F33	R1-I2-F6
k	S	--	--	--
l	S	--	--	--
m	S	S	--	--
o	R3	R3	R3-I1-F5	R3-I3-F0
p	R4	R3	--	--
q	R1-I1-F2	R1	R1	--
r	R1	R1	R1	R1-I3-F15
s	S	--	--	--
t	--	R1	R1-I2-F3	--
u	--	R1	R1-I4-F3	R1-I3-F9
w	--	R1	--	--
x	--	--	S	--
y	--	--	S	--
z	--	--	S	--
aa	--	--	--	S
bb	--	--	--	R1
9.	S	--	--	--
b	R1-I1-F7	R2	R2-I1-F6	R2-I9-F32
c	R3-I3-F5	R3	R3-I3-F8	R3-I8-F27
d	S	R1	--	--
e	R2-I1-F2	R2	--	--
f	S	--	--	--
g	R2-I2-F6	--	--	--
h	S	R1	R1-I5-F22	R1-I6-F31
i	S	R2	R3	--
j	R2	R2	R2	R2
k	R1	R1	R1	R1
l	R1	R1	R1	R1-I8-F55
m	R3	R3	--	--

n	R2	R2	R2	R2-I3-F18
o	R2-I1-F2	R2	R2	R2-I5-F14
p	R3-I2-F4	R2	R2	R2-I5-F22
q	R2-I2-F4	--	--	--
r	R1-I3-F8	R1	R1-I4-F11	R1-I5-F14
s	R1	R1	R1-I2-F5	R1-I3-F9
t	--	S	--	--
u	--	R2	--	--
v	--	R2	R2	R1S1
w	--	--	R1	--
x	--	--	S	R1
y	--	--	S	R1
z	--	--	--	S
10.	R2	R2	--	--
b	R1-I3-F6	R1	--	--
c	R1	R1-I1-F2	R1-I5-F12	R1-I4-F13
d	R1	R1	R1-I1-F1	R1-I4-F21
e	R2-I2-F5	R2	R2-I2-F8	R2-I3-F9
f	S	--	--	--
g	S	--	--	--
h	R1-I6-F0	--	--	--
i	--	--	--	R1
j	--	--	--	R1-I3-F9
k	--	--	--	S
l	--	--	--	R1
m	--	--	--	S
11.	R3-I4-F8	R3	R3-I1-F4	R3-I11-F43
b	R1-I1-F2	R1	R1	R1S1
c	R1-I1-F1	R1	R1	R1-I4-F5
d	R3	--	--	--
e	R1	R1	R1	R1
f	R1	R1	R1	R1
g	R1	R1	R1	R1
h	R2	R2	R2	R2
i	R3-I3-F5	R3	R3	R3-I6-F7
j	--	--	S	R1
k	--	--	--	S
l	--	--	--	R1
12.	R2-I1-F4	--	--	--
b	R1-I1-F2	R1	R1-I1-F4	R1-I3-F13
c	R1-I1-F2	R1	--	--
d	R2	R2	R1	--
e	--	S	R2	R2
f	--	--	R1	R1
g	--	--	S	R1
h	--	--	S	R1-I2-F6
i	--	--	--	S3
j	--	--	--	S5

Birch Creek

<u>Plot #</u>	<u>1987</u>	<u>1988</u>	<u>1989</u>	<u>1990</u>
1.	R1	R1	R1-I1-F7	R1
b	R1	R1	R1	R1
c	R3	R4	--	--
d	R2-I3-F6	R2	R2-I1-F5	--
2.	R1	--*	--	--
b	R1	--*	--	--
c	R1	--*	--	--
d	R1	--*	--	--
e	R1	R1	R1-I8-F56	--
f	R1	--	--	--
g	R1-I1-F3	--	--	--
h	R1	R1	R1	--
i	R1	R1	R1-I7-F36	--
j	R1	R1	R1	R1
k	R1-I2-F3	--*	--	--
l	--	--	R1-I1-F5	--
m	--	--	--	R1
n	--	--	--	R1-I3-F6
3.	R1-I1-F1	--*	--	--
b	R1-I2-F4	--*	--	--
c	R1	--*	--	--
4.	R1	R1	R1	R1
b	R1	R1	R1	R1-I2-F0
c	--	R2	--	--
d	--	R1	--	--
e	--	R1	--	--
5.	R1	--	--	--
b	R1	R1	R1	R1
c	R1	R1	R1	--
d	R1	--	--	--
e	R1	R1	R1	R1
f	R2-I1-F6	R1	--	--
g	R1	R1	R1	R1
h	--	--	R1	R1
i	--	--	--	R1
6.	R1	--	--	--
b	R1	R1	R1	R1
c	R1-I1-F3	R1	R1	R1
d	R1-I2-F6	R1-I3-F9	R1-I2-F3	R1
e	R2-I2-F5	--	--	--
f	R1	--	--	--
g	R1	R1-I2-F12	R1-I1-F5	R1-I2-F6
h	R1	R1	R1	R1S1

i	--	R2	R1	R1
j	--	R1	R3-I1-F3	R4-I3-F9
k	--	R1	R1	--
l	--	R1	R1-I4-F18	R1
7.	R1-I1-F1	R1	R1-I3-F13	R1-I1-F2
b	R1	--	--	--
c	R1-I2-F2	R1	R1-I5-F39	R1-I1-F5
d	R1	--	--	--
e	--	--	R2	--
f	--	--	R1-I2-F12	--
g	--	--	S	R1
8.	R1-I1-F3	R3	R3-I3-F17	R3-I1-F5
b	R1	R1	R1	R1-I1-F6
c	R1-I2-F4	R1	R1-I1-F3	--
d	R1	R1	--	--
e	R1	R1	--	--
9.	R2-I2-F5	---	--	--
b	R1-I3-F6	---	--	--
c	R1-I1-F5	---	--	--
d	R1	---	--	--
e	R2-I1-F2	---	--	--
10.	--	S	S	R1
b	--	S	--	--
c	--	--	--	R1
d	--	--	--	R1
e	--	--	--	R1
11.	R1	R1	--	--
b	R1	--	--	--
c	R1	--	--	--
d	R1	R1	R1-I2-F10	R1-I1-F0
e	R1	R1-I1-F3	R1-I5-F38	R1
f	--	R1	R1-I2-F10	R1
g	--	R1	R1	R1-I1-F2
h	--	R1	R1	R1
i	--	--	R1-I1-F8	R1
j	--	--	R1	R1-I3-F19
l	--	--	--	R1
12.	R1-I3-F7	R1	R1-I4-F21	R1
b	R1	R1	R1-I1-F5	R1-I2-F1
c	R1	--	--	--
d	R1	--	--	--
e	R1-I1-F1	--	--	--
f	R1	R1	R1	S
g	R1-I2-F3	R1	R1-I6-F22	--
h	R1	--	--	--
i	R1	R1	R1-I2-F10	R1

j	--	R1	R1-I5-F28	R1-I1-F2
k	--	R1	R1-I3-F11	R2
l	--	S	R1	S
m	--	S	S	S
n	--	S	S	S
o	--	R1	R1	R1-I1-F2
p	--	R1	R1	R1
q	--	--	R1	R1
r	--	--	R1	S
s	--	--	R1	R1
t	--	--	S	S
13.	NOT	R1	R1-I3-F7	R1-I1-F5b
b	RECORDED	R1	R1-I1-F5	R1-I2-F1b
c		R1-I1-F5	R1-I11-F78	--
d		R1	R1-I6-F35	--
e		R1	R2	R2
f		R1-I5-F22	R1-I3-F65 ^b	--
g		--	--	R1
h		--	--	R1
i		--	--	R1
14.	NOT	R1-I5-F34	R1-I4-F35	--
b	RECORDED	R1	R1	--
c		R1	R1	R1-I5-F4
d		R1	R1-I2-F83 ^b	--
e		R1-I2-F13	--	--
f		--	R2-I2-F12	R1
g		--	R1	--
h		--	R1	R1
i		--	--	S
j		--	--	S
k		--	--	S



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